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(54) I.c. engine starter motor

(57) The electric motor 7 has a stator 8 with at least eight poles 9 and a rotor shaft torsionally coupled directly to the engine drive pinion (30, Fig. 1). The motor and the pinion projecting electromagnet 18, 20, 21 are encosed in a protective casing 2, 3 of non-magnetic material, e.g. aluminium, aluminium alloy or thermosetting or heat-shrinkable plastics.

FIG. 2

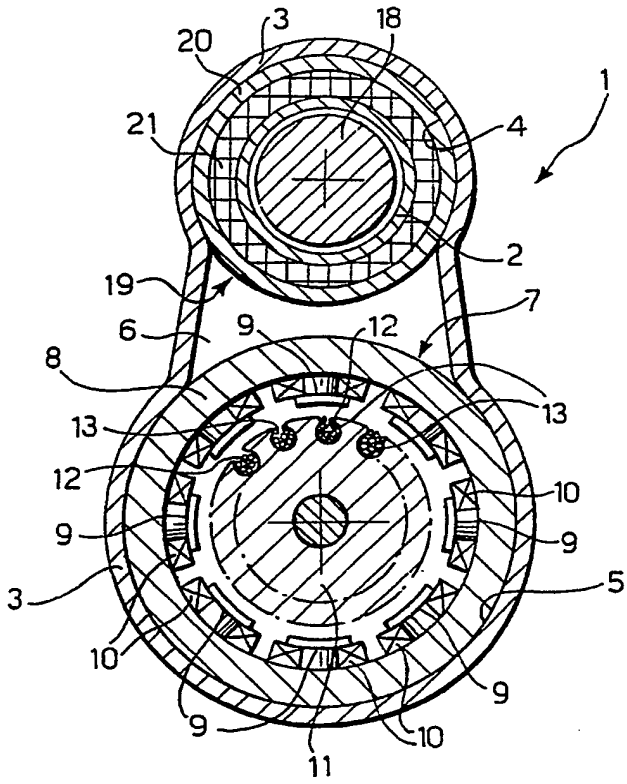

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FIG. 1

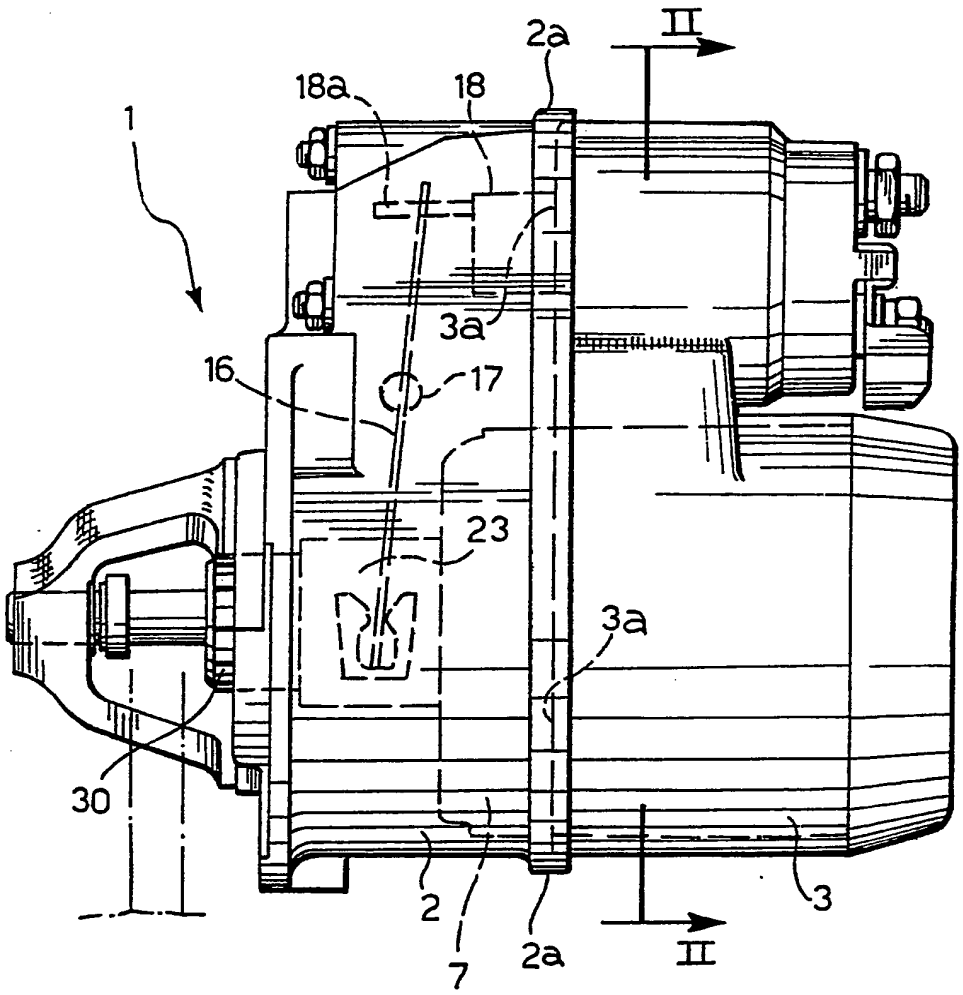
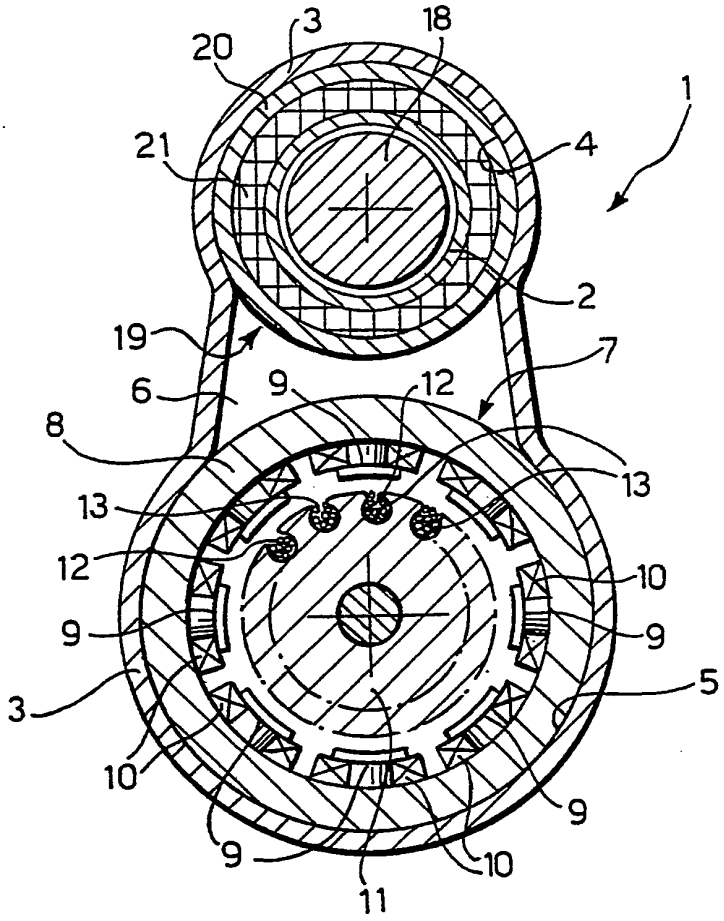


FIG. 2



"A starter device for a motor vehicle internal combustion engine"

The present invention relates to starter devices for motor vehicle internal combustion engines.

More specifically, the invention relates to a starter device comprising:

a support structure,

a pinion translatable with respect to this structure and intended to mesh with a toothed wheel of the internal combustion engine,

a control electromagnet including a core movable between a rest position and an actuation position,

a transmission between the core of the electromagnet and the pinion, and,

a DC electric motor which can be supplied as a result of the energisation of the electromagnet to drive the pinion to rotate.

Starter devices of this type have been and are to this day made in large numbers. In such devices the rotor shaft of the electric motor is torsionally coupled to the translatable pinion via a reduction gear, for example of the epicyclic type, and to an overrun clutch, typically of the freewheel type.

In such devices, when the electromagnet is energised, its core is attracted towards the actuation position and, by means of the said transmission, (which in many cases is simply a fork-shaped rocker arm) drives the translation of the pinion which then meshes with the teeth of a toothed wheel (flywheel) which can rotate the heat engine crank shaft.

The electromagnet is typically associated with a switch having a movable contact which is displaced by the translation of the core and which closes a current supply path to the electric motor at the end of the pinion stroke.

When the heat engine starts and its rate of rotation exceeds a predetermined value, the overrun clutch uncouples the electric motor shaft from the pinion avoiding damage to the motor.

The pinion disengages from the toothed wheel of the engine as soon as the electromagnet is de-energised.

Numerous problems are encountered in the production of the starter devices described above.

In fact, it is necessary for such devices to be robust and reliable while at the same time being small and quiet.

Motor vehicle manufacturers also require starter devices to be able to pass tests of resistance to hostile environments over fairly long periods of time (tests in salt and fog for example of 100 hours or more). To satisfy this latter requirement, some have adopted the solution of a galvanic treatment, for example by means of zinc, of the outer surface of the casing of the electromagnet and of the electric motor, which are typically made of magnetic materials which are only poorly resistant to the said aggressive agents.

The adoption of galvanic treatments, whilst solving the said problems at least in part, does however, involve not inconsiderable disadvantages from the point of view of costs, environmental pollution and flexibility and adaptability of the processes to variations in the required production rates.

The object of the present invention is to provide a starter device of the type specified above which is rather less bulky and very much lighter than previous devices and which, at the same time, is very well able to resist more severe tests of its resistance to aggressive agents.

This object is achieved according to the invention by means of a starter device of the type specified above, the principal characteristics of which lie in the fact that:

the said electric motor has a stator which includes at least eight poles and a rotor including a shaft torsionally coupled directly to the pinion, and in that:

the entire device is enclosed in a protective casing of non-magnetic material.

The adoption of a stator having at least eight poles makes it possible considerably to reduce the dimensions of the electric motor of the starter device, particularly in an axial sense.

The direct transmission of rotation from the rotor of the electric motor to the pinion, that is without any intermediate reduction unit, also achieves a reduction in size, weight and cost. The absence of a reduction unit also appreciably reduces the noise generated by the starter device in operation.

The direct torsional coupling (that is, with a transmission ratio of 1) between the rotor of the electric motor and the pinion can be achieved by using of an overrun clutch of conventional type, or else - and preferably - without recourse to such a clutch. Naturally, in this second case, in order to avoid damage to the electric starter motor once the heat engine has started, electronic starting control arrangements of known type can be adopted. Such systems include, for example, a sensor which provides a signal

indicative of the rate of rotation of the heat engine crank shaft and an electronic control unit which deactivates the starter device when the signal provided by the sensor indicates that the rate of rotation of the engine has reached a predetermined minimum self-sustaining value.

The reduction in size and weight which can be achieved by the above arrangements is such as to render the weight which a protective casing of non-magnetic material for the entire device can involve, at least tolerable, if not absolutely negligible.

The set of provisions to which the attached principal claim relates therefore allows the above defined objectives which form the basis of the present invention to be achieved synergistically.

Further characteristics and advantages of the invention will become apparent from the following detailed description, made with reference to the appended drawings, provided purely by way of non-limitative example, in which:

Figure 1 is a side view of a starter device according to the invention; and

Figure 2 is a section taken on the line II-II of Figure 1.

In Figure 1 a starter device for a motor vehicle internal

combustion engine is generally indicated 1. It comprises a support casing which, in the embodiment illustrated by way of example, is formed by two-half shells 2 and 3 fitted together and clamped by set screws (in known manner). These half-shells are made of light, non-magnetic material such as a thermosetting plastics material or else, and preferably, aluminium or one of its alloys. In the embodiment illustrated by way of example the half-shell 2 has an edge 2a into which is fitted a corresponding edge 3a of the half-shell 3.

As will better be seen from a joint observation of Figures 1 and 2, the half-shells 2 and 3 together form a casing which has a substantially 8-shape cross-section and defines an upper region 4 and a lower region 5 joined together by an intermediate region 6.

Within the lower region of the casing indicated 5 in Figure 2, there is housed a DC electric motor 7. This motor includes a stator 8 constituted by a stack of laminations having eight (at least) polar enlargements or poles 9 on its inner surface provided with respective stator windings 10.

The stator poles could be permanent magnets rather than being windings.

Within the stator 8 of the electric motor 7 is mounted a rotor 11 having a plurality of recesses 12 in its periphery which house electrical conductors 13.

The rotor 11 has, for example, twenty-one recesses, each of which houses four conductors.

The stator 8 can be made in an extremely compact manner so as, in particular, to have a very small axial dimension.

A sleeve 15 is axially slidable on the shaft of the electic motor 7 within the half shell 2 in known manner.

Reference numeral 16 indicates a rocker lever mounted in the half-shell 2 so as to be pivotable about a fulcrum 17 and serving as a transmission member between the sleeve 15 and an extension 18a of the core 18 of an electromagnet which, in Figure 2, is generally indicated 19. This electromagnet has a tubular casing 20 (Figure 2) of magnetic material within which is disposed an energising solenoid 21 carried by a coil 22 within which the core 18 is axially translatable.

The rocker lever 16 can conveniently be made in the manner illustrated in the prior patent application 53828-A/85 and therefore has a fork shape with two prongs which engage in corresponding seats 23 arranged on the sides of the sleeve

15 and one of which is visible in Figure 1.

The reference numeral 30 in Figure 1 indicates a pinion which, in known manner, is translatable relative to the shaft of the electric motor 7 as a result of a corresponding translational movement of the sleeve 15 on energisation of the electromagnet 19.

The pinion 30 is coupled to the shaft of the electric motor 7 in such a way as to be fixed to it for rotation with a 1:1 transmission ratio, without the interposition of any reduction unit. This can be achieved, for example, by means of a splined coupling.

When the electromagnet 19 is energised, the displacement of the core 18, via the lever 16 drives a translation of the sleeve 15 and of the pinion 30. This latter is thrust into meshing engagement with the teeth of a toothed wheel 40 (Figure 1) coupled for rotation with the crank shaft of the internal combustion engine which is to be started. The toothed wheel 40 may, for example, be the flywheel of the engine.

As in conventional starter devices, once the pinion 30 has meshed with the toothed wheel 40, a switch (not illustrated, but of an entirely conventional type) associated with the electromagnet 19 allows current to be

supplied to the electric motor 20 whose shaft rotates the said pinion.

As mentioned above, the starter device of the invention is preferably not provided with an overrun clutch. In this case, the starter device must be associated with an electronic control system which de-activates the electric motor 7 as soon as the heat engine has reached or exceeded the minimum self-sustaining speed.

Alternatively, however, the starter device of the invention may include an overrun clutch operable to uncouple the pinion torsionally from the electric motor shaft when the internal combustion engine exceeds the self-sustaining speed.

The adoption of a stator having a large number of poles and the elimination of the reduction unit and, optionally of the overrun clutch make it possible to form the starter device with extremely small dimensions and weight. In particular, it is possible to make a starter device which is able to develop a power of the order of 1 kw and with a weight of significantly less than 3 kg.

This drastic reduction in weight and dimensions makes the increase in weight and dimensions resulting from the adoption of a non-magnetic casing resistant to aggressive

agents certainly tolerable, and almost negligible.

This makes is possible fully to achieve the objectives mentioned in the introduction to the present specification.

In an alternative embodiment, the starter device may not be provided with an integral casing of aluminium or an alloy thereof but may be made with a supporting structure of the conventional type described, for example, in the prior Italian patent application 54288-B/85, in particular, with the casings of the electromagnet and of the stator of the electric motor not encapsulated in a casing of non-magnetic metal material. In this case conveniently, in place of this metal cladding, consideration can be given to a cladding of heat shrinking plastics material.

Naturally, the principle of the invention remaining the same, the embodiments and details of construction can be varied widely with respect to what has been described and illustrated purely by way of non-limiting example, without thereby departing from the scope of the present invention.

2. A starter device according to Claim 1, characterised in that the casing is of aluminium or an alloy thereof.

3. A starter device according to Claim 1, characterised in that the casing is of thermosetting plastics material.

4. A starter device according to Claim 1, characterised in that the casing is constituted by a heat-shrinking plastics film.

5. A starter device according to Claim 2 or Claim 3, characterised in that the casing has an 8-shaped transverse section, and defines an upper region housing the said electromagnet , and a lower region housing the electric motor .

6. A starter device for an internal combustion engine substantially as herein described with reference to the accompanying drawings.